

DOE/CE/15604-J4

COAL AIR TURBINE "CAT" PROGRAM

INVENTION 604

BY

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FOURTH QUARTER PROJECT REPORT (July-September 1995)

OCTOBER 31, 1995

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"CAT" PROJECT INVENTION 604  
QUARTERLY REPORT TABLE OF CONTENTS

	Page
1.0 Project Objective.....	1
2.0 Project Overview.....	2
3.0 Project Progress Summary.....	4
4.0 Project Task Reports.....	6
4.1 Task 1 - Selection of AE.....	6
4.1.1 Task Description	
4.1.2 Task Status and Activity in Current Quarter	
4.2 Task 2 - Conceptual Design "CAT".....	6
4.2.1 Task Description	
4.2.2 Task Status and Activity in Current Quarter	
4.2.3 Activity Planned in next Quarter	
4.3 Task 3 - Conceptual Design of Gas Turbine Mods.....	7
4.3.1 Task Description	
4.3.2 Task Status and Activity in Current Quarter	
4.3.3 Activity Planned in next Quarter	
4.4 Task 26 - Combustion System Conceptual Design.....	7
4.4.1 Task Description	
4.4.2 Task Status and Activity in Current Quarter	
4.4.3 Activity Planned in next Quarter	
4.5 Task 4 - Used Gas Turbine Survey.....	8
4.5.1 Task Description	
4.5.2 Task Status and Activity in Current Quarter	
4.5.3 Activity Planned in next Quarter	
4.6 Task 5 - CAT Competitive Analysis.....	8
4.6.1 Task Description	
4.6.2 Task Status and Activity in Current Quarter	
4.7 Task 6 - CAT Design Fine Tune (No Activity)	
4.8 Task 7 - Consortium Packet (No Activity)	
4.9 Task 8 - Consortium Meeting Preparation (No Activity)	
4.10 Task 9 - Consortium Meeting (No Activity)	
4.11 Task 10 - Quarterly/Final Reports to DOE.....	8
5.0 Financial Status.....	9
5.1 Sources and Uses of Funds Oct 1994 - Sept 1995.....	10
DOE Advance Payment Request Experience.....	10
5.2 Payee Report for Oct 1994-Sep 1995.....	11
5.3 Month Report for Oct 1994-Sep 1995.....	14
5.4 Task Report for Oct 1994-Sep 1995.....	17
6.0 Current Project Plan.....	20
6.1 Project PERT Chart.....	21
6.2 Project Financial Plan.....	22

### 1.0 Project Objective

The primary objective of this "CAT" project is to complete a conceptual design of this unique new combination of existing technology with cost estimates to show that the "CAT" system offers the economic incentive with low technical risk for a plant to be built which will demonstrate its viability.

The technologies involved in the components of a "CAT" plant are proven, and the integration of the components into a complete plant is the only new developmental activity involved.

Industry and the Federal General Services Administration (GSA), require the demonstration of a "commercial plant" before the viability of a new concept is accepted. To satisfy this requirement the construction of a plant of commercially viable size in excess of 15 MW if cogeneration and above 30 MW if all power, is proposed. This plant will produce economical power and heat for the owner. The plant will operate for a full commercial life and continue as an operating demonstration of the viability of the technology, gathering long term life and maintenance data, all adding to the credibility of the concept.

## 2.0 Project Overview

The "CAT" System is an innovative new use of existing technology in a unique configuration which will be more cost effective than competitive systems.

In layman's language a Coal Air Turbine "CAT" generates electric power or cogenerates electric power and heat for process use from the burning of coal. Cogeneration, the sequential generation of electricity and heat, is more efficient and economical than their separate production.

Commercial "CAT" power plants with outputs up to 100 MW will be the outcome of this program. The "CAT" plants are expected to be 10% more cost effective than current state of the art plants with the same output.

The major components of "CAT" plants are an air turbine, a heater of compressed air, a coal combustion system, means to recover waste heat and a steam turbine when appropriate. An air turbine is the same as a gas turbine except that it runs on hot air.

The "CAT" plant burns raw coal in a fluid bed at atmospheric pressure. The air turbine operates on clean compressed air heated inside tubes immersed in the fluid bed, thus it is called an "Air Turbine" and the cycle is called a Coal Air Turbine, or "CAT", cycle. Heat is recovered from the exhaust of the air turbine and the coal combustor, to produce steam for process use and / or for driving a steam turbine to generate more power. In a version producing only electric power, the steam is expanded in a steam turbine, condensed and recirculated, instead of the steam being exported for an external use.

Gas turbines now built operate at hotter temperatures than air heaters can produce and if operated at the lower temperatures which air heaters can deliver would be less efficient and more costly. Thus, gas turbines built in the past, which operate with a turbine inlet temperature matching the temperature capability of fluid bed air heaters, are more suitable for "CAT".

Until new gas turbines are again made available for temperatures suitable for air heaters, surplus used gas turbines will be purchased, reconditioned and modified to use hot air from the air heater instead of from combustors.

The operation of fluid bed air heaters has been proven by DOE and others in many tests extending over twenty years. Many metal alloys in many configurations of fluid bed air heaters have been operated for thousands of hours. Suitable alloys and arrangements have been identified. Manufacturers now offer air heaters for the proposed operating conditions with normal commercial warranties. A Circulating Fluid Bed (CFB) combustor will be used to burn the coal. The CFB emits the least sulfur, oxides of nitrogen and particulate material of all the coal combustion systems and meets the most rigorous emission regulations.

In "CAT" cycles, heat can be recovered from the clean, breathable hot air exhausted by the air turbine for production of steam for coal drying, paper drying, building heat or more power generation.

The following features will result in the production of low cost power by a "CAT" plant:

1. Inexpensive, plentiful coal fuel.
2. Simple efficient coal combustion at atmospheric pressure. (Not pressurized fluid bed or gasification.)
3. Simple emission control by limestone and baghouses.
4. A steam turbine for power generation is unnecessary for cogeneration (but may be used if advantageous).
5. The low cost, low temperature used gas turbines are readily available.

Where coal is competitive, a "CAT" plant will be more economical at capacities above 10 MW for cogeneration and for power generation at capacities above 30MW.

### 3.0 Project Progress Summary

In June the "CAT" study encountered an impasse in the design and cost estimate of a key component of the "CAT" plant, namely the circulating fluid bed air heater system. This will cause a six month delay in completion of the project. The project has been rescheduled to be completed March 31, 1996 with final report to be delivered, as required, 90 days thereafter on June 30, 1996. While this impasse is being resolved, the work by the architect engineer, Gilbert/Commonwealth was placed on hold to conserve funds. We are pleased to report that a solution has been found to the problem of the cost of the circulating fluid bed and progress with the study at the architect engineer will resume shortly. The final report to DOE will be completed within the allocated funding as a result of a hold being placed on expenditures during the delay. While waiting for information on the circulating fluid bed, work has proceeded on sections of the final report for which information is available.

#### Problem Summary

It is intended that proposals of "CAT" plants will be made, orders obtained and plants constructed. This study report will be used to attract interest and to do so the report must be credible. The coal fired circulating fluid bed air heater system is the most novel item in "CAT", thus the circulating fluid bed air heater in the study must be based on a real design.

Requests were made to many designers and manufacturers of circulating fluid bed combustion systems for designs and costs of systems for the "CAT" plant. No manufacturer was willing to supply this information at a cost which the program could afford.

The manufacturers of CFB systems listed below were all invited to participate and either failed to answer our enquiries or declined explaining that they no longer manufactured the systems, or were too busy. Several of the companies have accepted contracts from DOE to design CFB air heater systems in the past, and have published reports of their designs and tests with statements of the technical feasibility. It is a great disappointment that these companies which accepted taxpayers money to prove the feasibility of the concept and in the process obtained useful research information, have proven unwilling to cooperate in this study.

#### Companies solicited for CFB designs

ABB Combustion Engineering, Windsor, Connecticut.\*

Babcock & Wilcox, Barberton, Ohio.\*

Combustion Power, San Francisco, Cal.

Foster - Wheeler, New Jersey.\*

Pyropower, San Diego, Cal.

Riley-Deutsche Babcock, Worcester, Mass.

Struthers-Wells, Warren, Pa.

Tampella, Williamsport, Pa.

Zurn Industries, Erie, Pa.

\* Have accepted DOE research contracts on fluid bed air heaters.

Requests for proposals to participate in the "CAT" study were sent to each of the above companies. Several follow up phone calls were made. Unfortunately no favorable response was forthcoming.

The publication of a report with a hypothetical circulating fluid bed system which lacked credibility would fail to achieve the objectives of the study. When it became apparent that manufacturers would not offer a design and cost estimate, the study was put on hold while alternatives were investigated.

#### The Solution

The "inventor" was involved in several proposals of "CAT" plants in previous employment and also was informed of proposals by others also promoting "CAT" through the engineers grape vine. (None of the proposals came to fruition). Persuading these leads the writer succeeded in obtaining the offer of comprehensive technical and cost information relating to one of the circulating fluid bed air heater systems which had been proposed. This information will be forwarded to the writer shortly.

The organization providing this information, is associated with one of the companies listed above and wishes to remain anonymous. The organization will provide information on a circulating fluid bed air heater system which was part of a serious commercial proposal of a "CAT" cogeneration plant in 1985. The plant was not constructed because the company to which it would have been supplied lost market share to foreign competition. The system is somewhat smaller than the "CAT" plants now being investigated. The cost of the circulating fluid bed system will be adjusted for size and escalation between 1985 and present day using recognized cost ratios for combustion-boiler plants published by engineering organizations and in the literatures (E.G. Chemical Engineering).

The organization providing the information is making it available for a small charge. The information is expected momentarily.

If the conclusions of the present study being funded by DOE are favorable, further efforts will be made to obtain actual designs and cost estimates from the boiler manufacturers to add to the credibility of the present study.

#### 4.0 Project Task Reports

##### 4.1 Task 1 - Selection of AE

###### 4.1.1 Task Description

This task required: 1) Potential Contractor identification, 2) Contractor discussions to determine interest and capability, 3) Preparation of an RFP with detailed work scope description 4) Soliciting bids from qualified contractors, 5) Selection of the project AE.

###### 4.1.2 Task Status and Activity in the Current Quarter

This AE contract has been signed for the work defined. The contractor has agreed to perform additional tasks should unforeseen but required work be identified as the project progresses. Any new work would be at additional cost.

##### 4.2 Task 2 - Conceptual Design "CAT"

###### 4.2.1 Task Description

The purpose of this task is to prepare a conceptual design and a cost estimate of a "CAT" plant on a hypothetical site, and to compare the capital cost and cost of power and steam from the "CAT" plant with power produced by alternate power plants on the same site.

Three "CAT" plant configurations will be investigated as follows:

###### Cycle A - Condensing "CAT"

- "Wet" condenser tower (or river) cooling
- Steam injection for peaking
- Coal fuel.

###### Cycle B - Cogeneration "CAT"

- Back-pressure steam turbine.
- Steam export and steam injection.
- Coal fuel.

###### Cycle C - Cogeneration "CAT"

- No steam turbine.
- Steam export and steam injection.
- Waste coal fuel.

Deliverables will include:

- Site layout drawings
- Equipment layout drawings
- Estimates of Total Plant Costs
- Estimates of the cost of power
- Final report

The final report will be the main report developed in the project and will include information developed/produced in other tasks and by Foster-Pegg Associates.



#### 4.2.2 Task Status and Activity in the Current Quarter

Gilbert Commonwealth has been on hold during this period pending resolution of the problem with the combustion system as explained in the Project Progress Summary.

#### 4.2.3 Activity Planned in the Next Quarter

Gilbert will start work again, likely in November, as soon as the information on the circulating fluid bed system is available.

### 4.3 Task 3 - Conceptual Design of Gas Turbine Modifications

#### 4.3.1 Task Description

This task requires: 1)Identifying qualified contractors, 2)Discussing the requirement with prospective contractors, 3)Preparing a RFP to solicit bids, 4)Requesting bids, 5)Selecting a contractor

#### 4.3.2 Task Status and Activity in the Current Quarter

The definition of modifications in more detail has been successful in obtaining commitments from contractors for the costing of this work. Revak Turbomachinery Services will do all modifications and Gilbert will do the piping.

#### 4.3.3 Activity Planned in the Next Quarter

With contractors now identified for this work, this task can now proceed on a desirable schedule.

### 4.4 Task 26 - Combustion System Conceptual Design

4.4.1 This task was added during the first quarter in order to obtain more detailed design information and more accurate cost estimates on this very vital part of the "CAT" plant. This would include conceptual designs, performance and cost estimates of the Circulating Fluid Bed and Air Heater components for the 3 cycles being investigated. Information requested for each cycle includes:

- Specifications.

- Drawings for layout purposes.

- Costs for inclusion in the overall cost estimates.

- Performance.

- Descriptive Material for inclusion in a report.

This request includes all primary components and auxiliary elements needed for the combustion system.

#### 4.4.2 Task Status and Activity in the Current Quarter

The Project Progress Summary of this report explains this activity. This was the primary activity of the quarter.

#### 4.4.3 Activity Planned in the next Quarter

The combustion system information should be received in November and will allow the whole project to restart.

#### 4.5 Task 4 - Used Gas Turbine Survey

##### 4.5.1 Task Description

The purpose of this task is to survey the availability and cost of used gas turbines. The scope of information desired is as follows:

- . Type and number of gas turbines offered for resale by year.
- . Type and number of gas turbines resold by year.
- . Sources of used gas turbines, by country, by industry.
- . Resale price range of gas turbines by type.
- . Cost of refurbishing resold gas turbines by type.
- . Cost of moving and installing pre-owned gas turbines by type.
- . List of vendors offering pre-owned gas turbines.
- . Purchasers of preowned gas turbines.
- . Impediments to the use of preowned gas turbines  
Insurance, Financial, Utility commissions, etc.

##### 4.5.2 Task Status and Activity in Current Quarter

It continues to be encouraging to find that there is an active market in the used turbines of the type suitable for "CAT" plants. There should be no problem in obtaining as many turbines as will be needed for "CAT" plants. PSIG has identified 20 GE Frame 5s available in the Houston area alone.

##### 4.5.3 Activity Planned in the next Quarter

Information obtained will be consolidated for inclusion into the final project report.

#### 4.6 Task 5 - CAT Competitive Analysis

##### 4.6.1 Task Description

This task is to provide comparative results to be expected with a "CAT" plant relative to competitive alternative type plants.

##### 4.6.2 Task Status and Activity in the Current Quarter

There has been no activity on this task.

#### 4.11 Task 10 - Quarterly/Final Reports to DOE

##### 4.11.1 Task Description

This task is to provide quarterly progress reports and a final report to DOE. As per the current schedules these reports will be as follows:

- . 1st Quarter Report for Oct-Dec 1994 due 1/31/95 (Delivered)
- . 2nd Quarter Report for Jan-Mar 1995 due 4/30/95
- . 3rd Quarter Report for Apr-Jun 1995 due 7/31/95
- . 4th Quarter Report for Jul-Sep 1995 due 10/31/95
- . 5th Quarter Report for Oct-Dec 1995 due 12/31/95
- . 6th Quarter Report for Jan-Mar 1996 due 3/31/96
- . Final Report due per new schedule on 6/30/96

Per the new project schedule, this project will be completed in March, 1996 so that the Final Report will be due 90 days following the end of the project.

### 5.0 Financial Status

The plan submitted November 11, 1994 has continued to be modified to reflect the slower use of funds due to Gilbert/Commonwealth schedule change dictated by the delay in firming up of the design of the combustion system.

This section shows the Sources and Uses of Funds Summary and the DOE Advance Payment Request Experience. This advanced payment process has been very satisfactory. Also provided in this section are the detailed spreadsheets which show the experience for the first quarter Oct-Dec 1994, the second quarter Jan-Mar 1995, the third quarter Apr-Jun 1995, and the fourth quarter Jul-Sep 1995.

FPSAUOF SOURCES AND USES OF FUNDS SUMMARY THRU SEPTEMBER 30, 1995

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Date	DOE	Fund	PSIG	Total	Project	Johnson	Gilbert	Expense	Total	Funds Received	Less Expense
12/05/94		6114.00		6114.00							
12/19/94		6250.00		6250.00							
01/03/95		7391.00		7391.00							
01/16/95		12556.00		12556.00							
02/06/95		16028.00		16028.00							
04/03/95		13203.00		13203.00							
04/18/95		8131.00		8131.00							
06/24/95		12096.00		12096.00							
12/19/94			5000.00	5000.00							
1/06/95			13040.50	13040.50							
2/09/95			5095.70	5095.70							
3/06/95											
4/12/95											
4/20/95											
5/24/95											
6/07/95											
6/26/95											
8/11/95											
TOTAL		82369.00		82369.00	23136.20M	6717.58		26800.00	56653.78	25715.22	

M R.H.Foster-Pegg has earned but not withdrawn an additional \$12921.15 as shown in the Paysee Report provided.

DOE ADVANCE PAYMENT REQUEST EXPERIENCE

Request Number	For Period	Date Sent	Date Received	Amount	Days Request in Process
1	10/6-11/6/94	10/11/94	12/5/94	6114.00	55
2	11/7-12/7/94	10/27/94	12/19/94	6250.00	53
3	12/8-1/6/95	11/14/94	1/3/95	7391.00	50
4	1/7-2/5/95	12/7/94	1/15/95	12556.00	40
5	2/6-3/6/95	12/29/94	2/6/95	16028.00	39
6	3/7-4/6/95	2/20/95	4/3/95	13203.00	41
7	4/7-5/5/95	3/7/95	4/18/95	8131.00	42
8	6/1-6/30/95	5/24/95	6/24/95	12096.00	31
9	8/1-8/31/95	7/25/95			
10	9/1-9/30/95	9/13/95			

Check received but lost; being replaced

Expense Categories: 1)Personnel, 2)Travel, 3)Contractual,  
4)Other such as telephone,copying,postage,office expense

PAYEE	TASK	MO	DA	YR	END OF MONTH	AMOUNT DUE	HRS	CATEGORY	WORK DESCRIPTION	PAYMENT DATE	AMOUNT
Total:						\$0.00	0.0				\$0.00
Gilbert/C	2	04	12	95		\$13400.00	3		Conceptual Design "CAT"	4/12/95	\$13400.00
		05	20	95		\$13400.00	3		Conceptual Design "CAT"	5/20/95	\$13400.00
Total:						\$26800.00	0.0				\$26800.00
R.W.Foster-Pegg	1	10	31	94		\$474.00	15.8	1	A&E Selection		
			31	94		\$25.00		2	Travel		
			31	94		\$98.50		4	A&E Selection Support		
	10	01	31	95		\$60.00	2.0	1	Rpts to DOE		
		04	30	95		\$15.00		2	DOE Reports		
		07	31	95		\$29.07		4	DOE Reports		
			31	95		\$10.00			DOE Reports		
	2	01	31	95		\$2643.00	88.1	1	Conceptual Design "CAT"		
			31	95		\$50.00		2	Conceptual Design "CAT"		
			31	95		\$269.00		4	Conceptual Design "CAT"		
		02	28	95		\$3021.00	100.7	1	Conceptual Design "CAT"		
			28	95		\$256.25		2	Conceptual Design "CAT"		
			28	95		\$223.00		4	Conceptual Design "CAT"		
		03	31	95		\$3465.00	115.5	1	Conceptual Design "CAT"		
			31	95		\$75.00		2	Conceptual Design "CAT"		
			31	95		\$210.00		4	Conceptual Design "CAT"		
		04	30	95		\$2430.00	81.0	1	Conceptual Design "CAT"		
			30	95		\$269.00		2	Conceptual Design "CAT"		
			30	95		\$75.00			Conceptual Design "CAT"		
		05	31	95		\$2010.00	67.0	1	Conceptual Design "CAT"		
			31	95		\$75.00		2	Conceptual Design "CAT"		
			31	95		\$261.15		4	Conceptual Design "CAT"		
		06	30	95		\$769.00	25.6	1	Conceptual Design "CAT"		
		07	31	95		\$339.00	11.3	1	Conceptual Design "CAT"		
		08	31	95		\$99.00	3.3	1	Conceptual Design "CAT"		
			31	95		\$80.00		4	Conceptual Design "CAT"		
		09	30	95		\$99.00	3.3	1	Conceptual Design "CAT"		
			30	95		\$40.00		2	Conceptual Design "CAT"		
		10	31	94		\$2492.00	83.1	1	Conceptual Design "CAT"		
			31	94		\$127.00		2	Travel		
			31	94		\$27.00		4	Task 2 Support		
		11	30	94		\$2984.00	99.5	1	Conceptual Design "CAT"		
			30	94		\$150.00		4	Task 2 Support		
		12	30	94		\$2014.00	67.1	1	Conceptual Design "CAT"		
			30	94		\$263.00		2	Travel		
			30	94		\$269.00		4	Task 2 Other support		
	26	01	31	95		\$342.00	11.4	1	Combustion System consulting		
			31	95		\$50.00		4	Combustion System Consulting		
		02	28	95		\$330.00	11.0	1	Combustion System		
			28	95		\$41.45		4	Combustion System		
		03	31	95		\$330.00	11.0	1	Combustion System		
			31	95		\$50.00		4	Combustion System		
		04	30	95		\$399.00	13.3	1	Combustion System		
			30	95		\$50.00		4	Combustion System		
		05	31	95		\$399.00	13.3	1	Combustion System		
		07	31	95		\$360.00	12.0	1	Combustion System		
			31	95		\$45.00		4	Combustion System		
		08	5	5		\$99.00	3.3	1	Combustion System		

PAYEE	TASK	MO	DA	YR	END OF MONTH	AMOUNT DUE	HRS	CATEGORY	WORK DESCRIPTION	PAYMENT DATE	AMOUNT
R.W.Foster-Pegg	26	09	30	95		\$99.00	3.3	1	Combustion System		
		12	30	94		\$332.00	11.1	1	Combustion System Consulting		
			30	94		\$40.00		4	Task 26 other support		
	3	01	31	95		\$600.00	20.0	1	Conceptual Des.GT Mods		
		02	28	95		\$898.00	29.9	1	Conceptual Design GT Mods		
		03	31	95		\$555.00	18.5	1	Conceptual Des.GT Mods		
		05	31	95		\$819.00	27.3	1	Gas Turbine Design		
		06	30	95		\$554.00		2	Conceptual Des.GT Mods		
		07	31	95		\$399.00	13.3	1	Conceptual Design GT mods		
			31	95		\$264.00		2	Conceptual Design GT mods		
		08	5	5		\$99.00	3.3	1	Conceptual GT Mods		
		09	30	95		\$99.00	3.3	1	Conceptual Design GT Mods		
		10	31	94		\$1575.00	52.5	1	Conceptual Design GT Mods		
			31	94		\$325.00		4	Task 2 Support		
		11	30	94		\$1452.00	48.4	1	Conceptual Design GT Mods		
			30	94		\$124.00		4	Task 4 Other Support		
	4	01	31	95		\$300.00	2.0	1	Used Gas Turbine Survey		
			31	95		\$60.00		2	Used Gas Turbine Survey		
			31	95		\$35.00		4	Used Gas Turbine Survey		
		02	28	95		\$297.00	9.9	1	Used Gas Turbine Survey		
			28	95		\$29.00		4	Used Gas Turbine Survey		
		04	30	95		\$111.00	3.7	1	Used Gas Turbine Survey		
		11	30	94		\$477.00	15.9	1	Used Gas Turbine Survey		
			30	94		\$50.00		4	Task 4 Other Support		
		12	30	94		\$298.00	9.9	1	Used Gas Turbine Survey		
			30	94		\$35.00		4	Task 4 other support		
	5	07	31	95		\$480.00	16.0	1	CAT Competitive Analysis		
	6	07	31	95		\$300.00	10.0	1	CAT Design Fine Tune		
			31	95		\$145.00		4	CAT Design Fine Tune		
	P	02	09	95						02/09/95	\$13040.50
		03	06	95						03/06/95	\$5095.70
		07	31	95						8/1/95	\$3564.15
		12	19	94						12/19/94	\$5000.00
Total:						\$39142.42	1136.9				\$26700.35
W.H.Johnson	1	10	31	94		\$120.00	4.0	1	A&E Selection		
			31	94		\$12.50		4	A&E Selection Support		
	10	01	31	95		\$300.00	10.0	1	Reports to DOE		
			31	95		\$25.00		2	Reports to DOE		
			31	95		\$67.00		4	Reports to DOE		
		04	30	95		\$360.00	12.0	1	DOE Reports		
			30	95		\$10.00		2	DOE Reports		
			30	95		\$67.00		4	DOE Reports		
		06	30	95		\$75.00	2.5	1	DOE Reports		
		07	31	95		\$285.00	9.5	1	DOE Reports		
			31	95		\$15.00		4	DOE Reports		
			31	95		\$37.93			DOE Reports		
	2	01	31	95		\$396.00	13.2	1	Conceptual Design "CAT"		
		02	28	95		\$624.00	20.8	1	Conceptual Design "CAT"		
			28	95		\$4.75		2	Conceptual Design "CAT"		
			28	95		\$46.00		4	Conceptual Design "CAT"		
		03	31	95		\$180.00	6.0	1	Conceptual Design "CAT"		
			31	95		\$59.00		4	Conceptual Design "CAT"		
		05	31	95		\$180.00	6.0	1	Conceptual Design "CAT"		
			31	95		\$5.85		4	Conceptual Design "CAT"		

Expense Categories: 1)Personnel, 2)Travel, 3)Contractual,

4)Other such as telephone,copying,postage,office expense

PAYEE	TASK	MO	DA	YR	END OF MONTH	AMOUNT DUE	HRS	CATEGORY	WORK DESCRIPTION	PAYMENT DATE	AMOUNT
W.H.Johnson	2	07	31	95		\$60.00	2.0	1	Conceptual Design "CAT"		
		10	31	94		\$514.00	17.1	1	Conceptual Design "CAT"		
		11	30	94		\$616.00	20.5	1	Conceptual Design "CAT"		
		12	30	94		\$416.00	13.9	1	Conceptual Design "CAT"		
	26	01	31	95		\$60.00	2.0	1	Combustion System Consulting		
		02	28	95		\$69.00	2.3	1	Combustion System		
			28	95		\$8.55		4	Combustion System		
		03	31	95		\$69.00	2.3	1	Combustion System		
		12	30	94		\$68.00	2.3	1	Combustion System Support		
	3	02	28	95		\$186.00	6.2	1	Conceptual Design GT Mods		
		03	31	95		\$45.00	1.5	1	Conceptual Des.GT Mods		
		10	31	94		\$325.00	10.8	1	Conceptual Design GT Mods		
		11	30	94		\$300.00	10.0	1	Conceptual Design GT Mods		
	4	01	31	95		\$60.00	2.0	1	Used Gas Turbine Survey		
		02	28	95		\$63.00	2.1	1	Used Gas Turbine Survey		
			28	95		\$6.00		4	Used Gas Turbine Survey		
		03	31	95		\$360.00	12.0	1	Used Gas Turbine Survey		
			31	95		\$33.00		4	Used Gas Turbine Survey		
		04	30	95		\$189.00	6.3	1	Used Gas Turbine Survey		
		05	31	95		\$150.00	5.0	1	Used Gas Turbine Survey		
		11	30	94		\$98.00	3.3	1	Used Gas Turbine Survey		
		12	30	94		\$62.00	2.1	1	Used Gas Turbine Survey		
	6	07	31	95		\$90.00		4	CAT Design Fine Tune		
P		01	07	95						01/07/95	\$2531.50
		02	10	95						02/10/95	\$908.00
		03	07	95						03/07/95	\$1007.30
		04	20	95						4/20/95	\$746.00
		05	23	95						5/23/95	\$626.00
		06	26	95						6/26/95	\$335.85
Total:						\$6717.58	207.7				\$6154.65

MO	DA	YR	PAYEE	TASK	END OF MONTH	AMOUNT DUE	HRS	CATEGORY	WORK DESCRIPTION
Total:						\$0.00	0.0		
01	31	95	R.W.Foster-Pegg	10		\$60.00	2.0	1	Rpts to DOE
	31	95		2		\$2643.00	88.1	1	Conceptual Design "CAT"
	31	95				\$50.00		2	Conceptual Design "CAT"
	31	95				\$269.00		4	Conceptual Design "CAT"
	31	95		26		\$342.00	11.4	1	Combustion System consulting
	31	95				\$50.00		4	Combustion System Consulting
	31	95		3		\$600.00	20.0	1	Conceptual Des.GT Mods
	31	95		4		\$300.00	2.0	1	Used Gas Turbine Survey
	31	95				\$60.00		2	Used Gas Turbine Survey
	31	95				\$35.00		4	Used Gas Turbine Survey
	31	95	W.H.Johnson	10		\$300.00	10.0	1	Reports to DOE
	31	95				\$25.00		2	Reports to DOE
	31	95				\$67.00		4	Reports to DOE
	31	95		2		\$396.00	13.2	1	Conceptual Design "CAT"
	31	95		26		\$60.00	2.0	1	Combustion System Consulting
	31	95		4		\$60.00	2.0	1	Used Gas Turbine Survey
Total:						\$5317.00	150.7		
02	28	95	R.W.Foster-Pegg	2		\$3021.00	100.7	1	Conceptual Design "CAT"
	28	95				\$256.25		2	Conceptual Design "CAT"
	28	95				\$223.00		4	Conceptual Design "CAT"
	28	95		26		\$330.00	11.0	1	Combustion System
	28	95				\$41.45		4	Combustion System
	28	95		3		\$898.00	29.9	1	Conceptual Design GT Mods
	28	95		4		\$297.00	9.9	1	Used Gas Turbine Survey
	28	95				\$29.00		4	Used Gas Turbine Survey
	28	95	W.H.Johnson	2		\$624.00	20.8	1	Conceptual Design "CAT"
	28	95				\$4.75		2	Conceptual Design "CAT"
	28	95				\$46.00		4	Conceptual Design "CAT"
	28	95		26		\$69.00	2.3	1	Combustion System
	28	95				\$8.55		4	Combustion System
	28	95		3		\$186.00	6.2	1	Conceptual Design GT Mods
	28	95		4		\$63.00	2.1	1	Used Gas Turbine Survey
	28	95				\$6.00		4	Used Gas Turbine Survey
Total:						\$6103.00	182.9		
03	31	95	R.W.Foster-Pegg	2		\$3465.00	115.5	1	Conceptual Design "CAT"
	31	95				\$75.00		2	Conceptual Design "CAT"
	31	95				\$210.00		4	Conceptual Design "CAT"
	31	95		26		\$330.00	11.0	1	Combustion System
	31	95				\$50.00		4	Combustion System
	31	95		3		\$555.00	18.5	1	Conceptual Des.GT Mods
	31	95	W.H.Johnson	2		\$180.00	6.0	1	Conceptual Design "CAT"
	31	95				\$59.00		4	Conceptual Design "CAT"
	31	95		26		\$69.00	2.3	1	Combustion System
	31	95		3		\$45.00	1.5	1	Conceptual Des.GT Mods
	31	95		4		\$360.00	12.0	1	Used Gas Turbine Survey
	31	95				\$33.00		4	Used Gas Turbine Survey
Total:						\$5431.00	166.8		



MO	DA	YR	PAYEE	TASK	END OF MONTH	AMOUNT DUE	HRS	CATEGORY	WORK DESCRIPTION
04	12	95	Gilbert/C	2		\$13400.00		3	Conceptual Design "CAT"
	30	95	R.W.Foster-Pegg	10		\$15.00		2	DOE Reports
	30	95		2		\$2430.00	81.0	1	Conceptual Design "CAT"
	30	95				\$75.00		2	Conceptual Design "CAT"
	30	95				\$269.00			Conceptual Design "CAT"
	30	95		26		\$399.00	13.3	1	Combustion System
	30	95				\$50.00		4	Combustion System
	30	95		4		\$111.00	3.7	1	Used Gas Turbine Survey
	30	95	W.H.Johnson	10		\$360.00	12.0	1	DOE Reports
	30	95				\$10.00		2	DOE Reports
	30	95				\$67.00		4	DOE Reports
	30	95		4		\$189.00	6.3	1	Used Gas Turbine Survey
Total:						\$17375.00	116.3		
05	20	95	Gilbert/C	2		\$13400.00		3	Conceptual Design "CAT"
	31	95	R.W.Foster-Pegg	2		\$2010.00	67.0	1	Conceptual Design "CAT"
	31	95				\$75.00		2	Conceptual Design "CAT"
	31	95				\$261.15		4	Conceptual Design "CAT"
	31	95		26		\$399.00	13.3	1	Combustion System
	31	95		3		\$819.00	27.3	1	Gas Turbine Design
	31	95	W.H.Johnson	2		\$180.00	6.0	1	Conceptual Design "CAT"
	31	95				\$5.85		4	Conceptual Design "CAT"
	31	95		4		\$150.00	5.0	1	Used Gas Turbine Survey
Total:						\$17300.00	118.6		
06	30	95	R.W.Foster-Pegg	2		\$769.00	25.6	1	Conceptual Design "CAT"
	30	95		3		\$554.00		2	Conceptual Des.GT Mods
	30	95	W.H.Johnson	10		\$75.00	2.5	1	DOE Reports
Total:						\$1398.00	28.1		
07	31	95	R.W.Foster-Pegg	10		\$10.00		4	DOE Reports
	31	95				\$29.07			DOE Reports
	31	95		2		\$339.00	11.3	1	Conceptual Design "CAT"
	31	95		26		\$360.00	12.0	1	Combustion System
	31	95				\$45.00		4	Combustion System
	31	95		3		\$399.00	13.3	1	Conceptual Design GT mods
	31	95				\$264.00		2	Conceptual Design GT mods
	31	95		5		\$480.00	16.0	1	CAT Competitive Analysis
	31	95		6		\$300.00	10.0	1	CAT Design Fine Tune
	31	95				\$145.00		4	CAT Design Fine Tune
	31	95	W.H.Johnson	10		\$285.00	9.5	1	DOE Reports
	31	95				\$15.00		4	DOE Reports
	31	95				\$37.93			DOE Reports
	31	95		2		\$60.00	2.0	1	Conceptual Design "CAT"
	31	95		6		\$90.00		4	CAT Design Fine Tune
Total:						\$2859.00	74.1		
08	31	95	R.W.Foster-Pegg	2		\$99.00	3.3	1	Conceptual Design "CAT"
	31	95				\$80.00		4	Conceptual Design "CAT"
	5	5		26		\$99.00	3.3	1	Combustion System
	5	5		3		\$99.00	3.3	1	Conceptual GT Mods

5.3 \*10/22/95(n)\* MONTH REPORT FOR FP604  
Expense Categories: 1)Personnel, 2)Travel, 3)Contractual,  
4)Other such as telephone,copying,postage,office expense

MO	DA	YR	PAYEE	TASK	END OF MONTH	AMOUNT DUE	HRS	CATEGORY	WORK DESCRIPTION
Total:						\$377.00	9.9		
09	30	95	R.W.Foster-Pegg	2		\$99.00	3.3	1	Conceptual Design "CAT"
	30	95				\$40.00		2	Conceptual Design "CAT"
	30	95		26		\$99.00	3.3	1	Combustion System
	30	95		3		\$99.00	3.3	1	Conceptual Design GT Mods
Total:						\$337.00	9.9		
10	31	94	R.W.Foster-Pegg	1		\$474.00	15.8	1	A&E Selection
	31	94				\$25.00		2	Travel
	31	94				\$98.50		4	A&E Selection Support
	31	94		2		\$2492.00	83.1	1	Conceptual Design "CAT"
	31	94				\$127.00		2	Travel
	31	94				\$27.00		4	Task 2 Support
	31	94		3		\$1575.00	52.5	1	Conceptual Design GT Mods
	31	94				\$325.00		4	Task 2 Support
	31	94	W.H.Johnson	1		\$120.00	4.0	1	A&E Selection
	31	94				\$12.50		4	A&E Selection Support
	31	94		2		\$514.00	17.1	1	Conceptual Design "CAT"
	31	94		3		\$325.00	10.8	1	Conceptual Design GT Mods
Total:						\$6115.00	183.3		
11	30	94	R.W.Foster-Pegg	2		\$2984.00	99.5	1	Conceptual Design "CAT"
	30	94				\$150.00		4	Task 2 Support
	30	94		3		\$1452.00	48.4	1	Conceptual Design GT Mods
	30	94				\$124.00		4	Task 4 Other Support
	30	94		4		\$477.00	15.9	1	Used Gas Turbine Survey
	30	94				\$50.00		4	Task 4 Other Support
	30	94	W.H.Johnson	2		\$616.00	20.5	1	Conceptual Design "CAT"
	30	94		3		\$300.00	10.0	1	Conceptual Design GT Mods
	30	94		4		\$98.00	3.3	1	Used Gas Turbine Survey
Total:						\$6251.00	197.6		
12	30	94	R.W.Foster-Pegg	2		\$2014.00	67.1	1	Conceptual Design "CAT"
	30	94				\$263.00		2	Travel
	30	94				\$269.00		4	Task 2 Other support
	30	94		26		\$332.00	11.1	1	Combustion System Consulting
	30	94				\$40.00		4	Task 26 other support
	30	94		4		\$298.00	9.9	1	Used Gas Turbine Survey
	30	94				\$35.00		4	Task 4 other support
	30	94	W.H.Johnson	2		\$416.00	13.9	1	Conceptual Design "CAT"
	30	94		26		\$68.00	2.3	1	Combustion System Support
	30	94		4		\$62.00	2.1	1	Used Gas Turbine Survey
Total:						\$3797.00	106.4		
Total:						\$72660.00	1344.6		

TASK	PAYEE	MO	DA	YR	END OF MONTH	AMOUNT DUE	HRS	CATEGORY	WORK DESCRIPTION
Total:						\$0.00	0.0		
1	R.W.Foster-Pegg	10	31	94		\$474.00	15.8	1	A&E Selection
			31	94		\$25.00		2	Travel
			31	94		\$98.50		4	A&E Selection Support
	W.H.Johnson	10	31	94		\$120.00	4.0	1	A&E Selection
			31	94		\$12.50		4	A&E Selection Support
Total:						\$730.00	19.8		
10	R.W.Foster-Pegg	01	31	95		\$60.00	2.0	1	Rpts to DOE
			04	30	95	\$15.00		2	DOE Reports
			07	31	95	\$29.07		4	DOE Reports
			31	95		\$10.00			DOE Reports
	W.H.Johnson	01	31	95		\$300.00	10.0	1	Reports to DOE
			31	95		\$25.00		2	Reports to DOE
			31	95		\$67.00		4	Reports to DOE
			04	30	95	\$360.00	12.0	1	DOE Reports
			30	95		\$10.00		2	DOE Reports
			30	95		\$67.00		4	DOE Reports
			06	30	95	\$75.00	2.5	1	DOE Reports
			07	31	95	\$285.00	9.5	1	DOE Reports
			31	95		\$37.93		4	DOE Reports
			31	95		\$15.00			DOE Reports
Total:						\$1356.00	36.0		
2	Gilbert/C	04	12	95		\$13400.00		3	Conceptual Design "CAT"
			05	20	95	\$13400.00		3	Conceptual Design "CAT"
	R.W.Foster-Pegg	01	31	95		\$2643.00	88.1	1	Conceptual Design "CAT"
			31	95		\$50.00		2	Conceptual Design "CAT"
			31	95		\$269.00		4	Conceptual Design "CAT"
			02	28	95	\$3021.00	100.7	1	Conceptual Design "CAT"
				28	95	\$256.25		2	Conceptual Design "CAT"
				28	95	\$223.00		4	Conceptual Design "CAT"
			03	31	95	\$3465.00	115.5	1	Conceptual Design "CAT"
				31	95	\$75.00		2	Conceptual Design "CAT"
				31	95	\$210.00		4	Conceptual Design "CAT"
			04	30	95	\$2430.00	81.0	1	Conceptual Design "CAT"
				30	95	\$75.00		2	Conceptual Design "CAT"
				30	95	\$269.00			Conceptual Design "CAT"
			05	31	95	\$2010.00	67.0	1	Conceptual Design "CAT"
				31	95	\$75.00		2	Conceptual Design "CAT"
				31	95	\$261.15		4	Conceptual Design "CAT"
			06	30	95	\$769.00	25.6	1	Conceptual Design "CAT"
			07	31	95	\$339.00	11.3	1	Conceptual Design "CAT"
			08	31	95	\$99.00	3.3	1	Conceptual Design "CAT"
				31	95	\$80.00		4	Conceptual Design "CAT"
			09	30	95	\$99.00	3.3	1	Conceptual Design "CAT"
				30	95	\$40.00		2	Conceptual Design "CAT"
			10	31	94	\$2492.00	83.1	1	Conceptual Design "CAT"
				31	94	\$127.00		2	Travel
				31	94	\$27.00		4	Task 2 Support
			11	30	94	\$2984.00	99.5	1	Conceptual Design "CAT"
				30	94	\$150.00		4	Task 2 Support

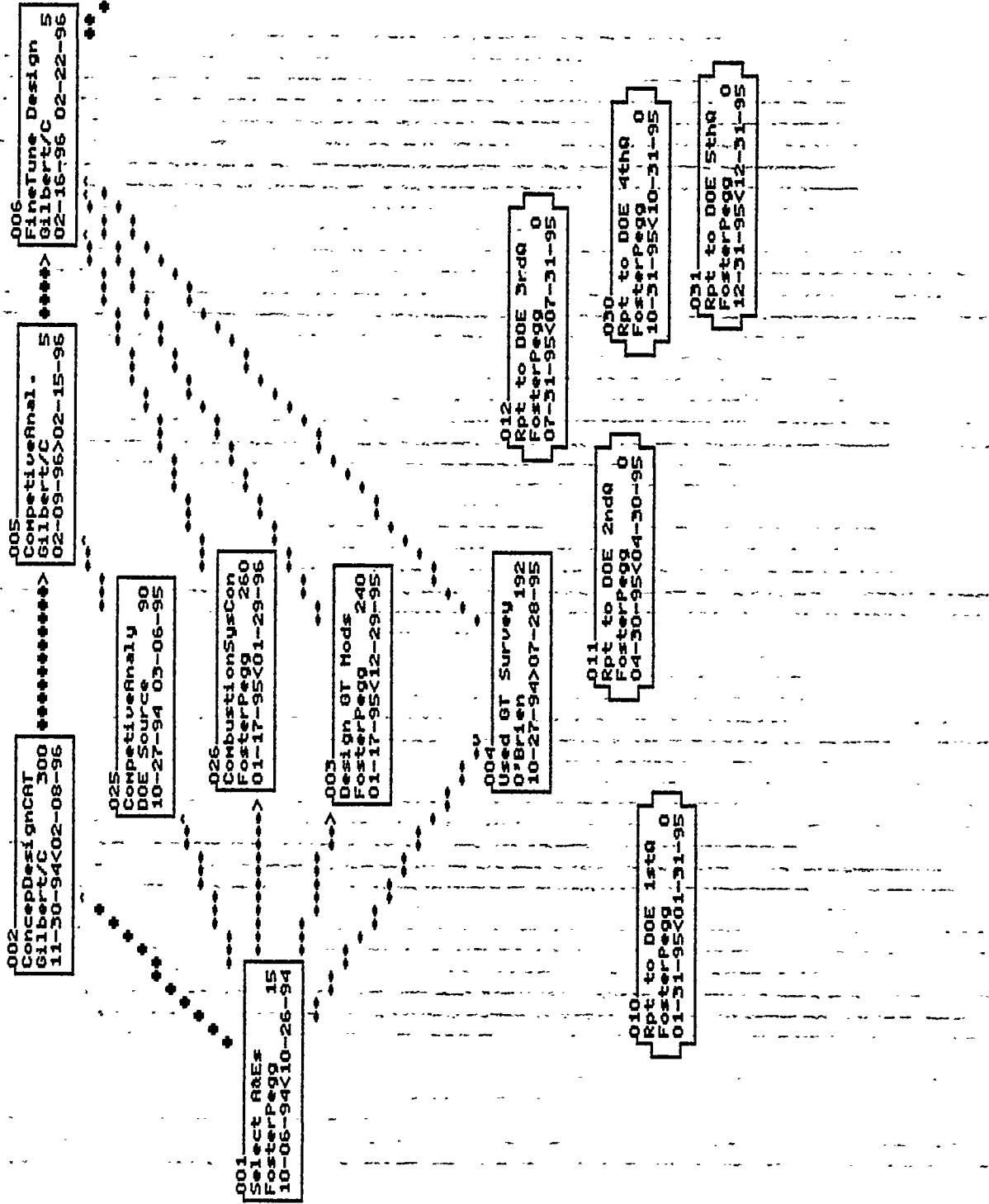
TASK	PAYEE	MO	DA	YR	END OF MONTH	AMOUNT DUE	HRS	CATEGORY	WORK DESCRIPTION
2	R.W.Foster-Pegg	12	30	94		\$2014.00	67.1	1	Conceptual Design "CAT"
			30	94		\$263.00		2	Travel
			30	94		\$269.00		4	Task 2 Other support
	W.H.Johnson	01	31	95		\$396.00	13.2	1	Conceptual Design "CAT"
		02	28	95		\$624.00	20.8	1	Conceptual Design "CAT"
			28	95		\$4.75		2	Conceptual Design "CAT"
			28	95		\$46.00		4	Conceptual Design "CAT"
		03	31	95		\$180.00	6.0	1	Conceptual Design "CAT"
			31	95		\$59.00		4	Conceptual Design "CAT"
		05	31	95		\$180.00	6.0	1	Conceptual Design "CAT"
			31	95		\$5.85		4	Conceptual Design "CAT"
		07	31	95		\$60.00	2.0	1	Conceptual Design "CAT"
		10	31	94		\$514.00	17.1	1	Conceptual Design "CAT"
		11	30	94		\$616.00	20.5	1	Conceptual Design "CAT"
		12	30	94		\$416.00	13.9	1	Conceptual Design "CAT"
Total:						\$54986.00	845.0		
26	R.W.Foster-Pegg	01	31	95		\$342.00	11.4	1	Combustion System consulting
			31	95		\$50.00		4	Combustion System Consulting
		02	28	95		\$330.00	11.0	1	Combustion System
			28	95		\$41.45		4	Combustion System
		03	31	95		\$330.00	11.0	1	Combustion System
			31	95		\$50.00		4	Combustion System
		04	30	95		\$399.00	13.3	1	Combustion System
			30	95		\$50.00		4	Combustion System
		05	31	95		\$399.00	13.3	1	Combustion System
		07	31	95		\$360.00	12.0	1	Combustion System
			31	95		\$45.00		4	Combustion System
		08	5	5		\$99.00	3.3	1	Combustion System
		09	30	95		\$99.00	3.3	1	Combustion System
		12	30	94		\$332.00	11.1	1	Combustion System Consulting
			30	94		\$40.00		4	Task 26 other support
	W.H.Johnson	01	31	95		\$60.00	2.0	1	Combustion System Consulting
		02	28	95		\$69.00	2.3	1	Combustion System
			28	95		\$8.55		4	Combustion System
		03	31	95		\$69.00	2.3	1	Combustion System
		12	30	94		\$68.00	2.3	1	Combustion System Support
Total:						\$3241.00	98.6		
3	R.W.Foster-Pegg	01	31	95		\$600.00	20.0	1	Conceptual Des.GT Mods
		02	28	95		\$898.00	29.9	1	Conceptual Design GT Mods
		03	31	95		\$555.00	18.5	1	Conceptual Des.GT Mods
		05	31	95		\$819.00	27.3	1	Gas Turbine Design
		06	30	95		\$554.00		2	Conceptual Des.GT Mods
		07	31	95		\$399.00	13.3	1	Conceptual Design GT mods
			31	95		\$264.00		2	Conceptual Design GT mods
		08	5	5		\$99.00	3.3	1	Conceptual GT Mods
		09	30	95		\$99.00	3.3	1	Conceptual Design GT Mods
		10	31	94		\$1575.00	52.5	1	Conceptual Design GT Mods
			31	94		\$325.00		4	Task 2 Support
		11	30	94		\$1452.00	48.4	1	Conceptual Design GT Mods
			30	94		\$124.00		4	Task 4 Other Support
	W.H.Johnson	02	28	95		\$186.00	6.2	1	Conceptual Design GT Mods
		03	31	95		\$45.00	1.5	1	Conceptual Des.GT Mods

TASK	PAYEE	MO	DA	YR	END OF MONTH	AMOUNT DUE	HRS	CATEGORY	WORK DESCRIPTION
3	W.H.Johnson	10	31	94		\$325.00	10.8	1	Conceptual Design GT Mods
		11	30	94		\$300.00	10.0	1	Conceptual Design GT Mods
Total:						\$8619.00	245.0		
4	R.W.Foster-Pegg	01	31	95		\$300.00	2.0	1	Used Gas Turbine Survey
			31	95		\$60.00		2	Used Gas Turbine Survey
			31	95		\$35.00		4	Used Gas Turbine Survey
		02	28	95		\$297.00	9.9	1	Used Gas Turbine Survey
			28	95		\$29.00		4	Used Gas Turbine Survey
		04	30	95		\$111.00	3.7	1	Used Gas Turbine Survey
		11	30	94		\$477.00	15.9	1	Used Gas Turbine Survey
			30	94		\$50.00		4	Task 4 Other Support
		12	30	94		\$298.00	9.9	1	Used Gas Turbine Survey
			30	94		\$35.00		4	Task 4 other support
	W.H.Johnson	01	31	95		\$60.00	2.0	1	Used Gas Turbine Survey
		02	28	95		\$63.00	2.1	1	Used Gas Turbine Survey
			28	95		\$6.00		4	Used Gas Turbine Survey
		03	31	95		\$360.00	12.0	1	Used Gas Turbine Survey
			31	95		\$33.00		4	Used Gas Turbine Survey
		04	30	95		\$189.00	6.3	1	Used Gas Turbine Survey
		05	31	95		\$150.00	5.0	1	Used Gas Turbine Survey
		11	30	94		\$98.00	3.3	1	Used Gas Turbine Survey
		12	30	94		\$62.00	2.1	1	Used Gas Turbine Survey
Total:						\$2713.00	74.2		
5	R.W.Foster-Pegg	07	31	95		\$480.00	16.0	1	CAT Competitive Analysis
Total:						\$480.00	16.0		
6	R.W.Foster-Pegg	07	31	95		\$300.00	10.0	1	CAT Design Fine Tune
			31	95		\$145.00		4	CAT Design Fine Tune
	W.H.Johnson	07	31	95		\$90.00		4	CAT Design Fine Tune
Total:						\$535.00	10.0		
Total:						\$72660.00	1344.6		

6.0 Current Project Plan

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The following shows the updated PERT Chart for the project and the revised Financial Plan for the total project.



----- Link      \*\*\*\* Critical Link      ----- HBS Link      ----- Task      ----- Critical Task

[illegible]